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Examining Teacher's Perceptions and Determinants of Difficulty in Teaching Chemistry Concepts

Boris Olutoyin Olufunke*
Department of Science Education,
Bamidele Olumilua University of Education, Science and Technology,
Ikere Ekiti, Nigeria
[**Corresponding author*]

Abstract
The study aims to investigate teacher's perceptions of difficulty in teaching chemistry concepts with a focus on the variables of gender, experience, and qualifications. One hundred and twelve (112) chemistry teachers were selected from all the schools in Ondo State Nigeria. Sampling approach was done based on gender, level of experience and qualifications. A self-designed questionnaire was used containing 30 chemistry concepts. The instrument was validated and tested for reliability. Findings from the study revealed that teacher's qualification and experience had a significant effect while gender had no significant effect on teacher's perceptions of difficulty in Chemistry. Teacher's reason for their perception were also ranked and analyzed. The findings contributed to a deeper understanding of the multifaceted dynamics shaping teaching practices in Chemistry education.

Keywords
Chemistry education, Teacher perceptions, Teaching difficulty, Gender, Experience, Qualifications

INTRODUCTION

In the realm of science education, Chemistry is a leading science subject because it helps students develop their critical thinking, skills and opens their minds to the wonders of the natural world, Bodner (2003). Despite its importance, chemistry education is fraught with difficulties due to the subject's abstract and complicated ideas (Taber, 2009). In this context, it is crucial to study how teachers perceive challenging chemistry ideas and what factors influence their perceptions in order to inform effective pedagogical practices and curriculum development.

Most people think chemistry is a fascinating field because of all the mathematics, experiments, and variety of topics covered in the course. Almost every facet of life science, from the physical to the biological sciences, relies on chemistry in some way, shape, or form. To enrol in university-level applied science programs, including engineering, technology, medicine, and others, chemistry is a necessary prerequisite. The field of chemistry deals with the study of natural principles that control the behaviour of the universe on all scales, from subatomic particles to the cosmos.

Learning chemistry is a great way to hone your critical thinking skills, develop your ability to ask insightful questions, and find creative solutions to complex issues. Graduates also receive process skills. Chemistry students are fearless because they know how to find the answers they need and where to find them. To that end, Ababio (2013) listed a number of chemistry-related occupations, including those in education, healthcare, food processing, the petroleum and photochemical industries, manufacturing, extractive industries, agriculture and forestry.

Among the many scientific disciplines, chemistry offers a methodical and rational framework for understanding the cosmos and its workings. It also includes all the information we have about the universe's inhabitants, both alive and non-living (Bradford, 2015). Factors associated with teachers, such as how they convey their understanding of the subject requirements to students, are one source of difficulty. The dogmatic approach to science teaching prevents students from engaging in meaningful verbal learning and forces them to rely on rote memorization of scientific facts and concepts.

Modern society is immensely complex and ever-changing, making chemistry and the chemical sciences crucial. Everyday life relies on them, and because of them, the world is able to respond quickly to some of the greatest challenges we face. Problems such as climate change, natural disasters, and the destruction of cities caused by chemical weapons exemplify these challenges (American Chemical Society, 2015). Teachers influence their actions in the classroom based

on the challenges students encounter when learning chemistry. The degree to which students comprehend and are able to apply course material is heavily dependent on teachers' perceptions of their own abilities, according to Adeyemo (2011).

A lot of things set public schools apart from private ones. They differ not only in ownership but also in administrative style and, on occasion, in what Mkpa (2002) termed "school productivity," or the academic achievement of students. Confirming whether student or instructor variables impact is necessary. In particular, the dismal academic results achieved by pupils enrolled in both public and private institutions. The methods utilized by science educators greatly impact the development of their pupils into esteemed scientists of the future. In order to help students develop the critical thinking and scientific literacy skills necessary for success in the modern world, science educators must use a variety of instructional tactics in the classroom. Regardless of individual differences, Azizoglu and Cetin (2009) argued that the goal of science education should be to foster a favourable attitude towards science.

The alarming rate at which science students are leaving for fields like the arts and business demands immediate action, regardless of the advances in the scientific community. Weak science education practices in secondary and higher education have been identified as the source of this issue. Educators have a significant impact on student achievement and are thus the most important resource for every school (Fadipe, 2003). Their success or failure as an educational system is dependent on them (Achimugu, 2005). This is in line with what the National Policy on Education (2013) said, which is that the quality of a school's teacher is the most important factor in determining the school's success. To sum up, according to Hakielimu (2011), the quality of education is mostly dependent on the teachers. Aina and Olanipekun (2015) said if a teacher lacks effective teaching strategies, their pupils will inevitably suffer. Teachers that are unable to inspire their pupils to learn, either through one-on-one time with the teacher or through group projects, will inevitably end up with subpar students.

Students in Nigeria struggle academically in science and technology from elementary school (basic education) all the way through Secondary school, according to research by Kurumeh and Imoko (2008). Additionally, students in elementary and secondary schools voiced their dissatisfaction with the difficulty of science and technology. Secondary school students' persistently have low science and technology performance on both internal and external exams undermines Nigeria's aspirations for technological advancement and economic emancipation, making it nearly impossible for students to gain admission to most science and technology courses at Nigerian universities. Improving pupils' performance in science and technology across all educational levels is crucial if Nigeria is to keep up with the expected technological advancements. The training and accountability of engineers, technicians, and scientists should be a top concern for any nation or country that wants to develop or create these professionals. Obodo (2000) bemoaned the fact that, there are multiple elements contributing to the ineffectiveness of science and technology education in Nigeria.

According to a large body of research on the topic of science, students will have a better grasp of the concepts covered in class if they see their teachers' interactions with them as collaborative rather than adversarial (Ahmed and Aziz 2009). According to Ajayi (2000), Oni (2006), Unoroh (2004), Boris (2016), students in Nigeria find scientific classes challenging since their teachers either don't care about the subject or aren't qualified to teach it. Both Ajayi (2000) and Oni (2006) found that students' perceptions of their teachers' attitudes and levels of interest in the sciences were significant contributors to their perceived difficulty. A teacher's outlook on chemistry has the power to inspire or depress their pupils. Factors such as teachers' qualifications, experience, and gender can influence students' perceptions of difficulty positively and negatively science education, according to research.

This research's primary goal is to examine the factors that influence teachers' views on the challenges of teaching chemical concepts. By zeroing in on chemistry teachers' backgrounds, credentials, and gender. Furthermore, this study aligns with the larger initiative to improve scientific education results and support professional development for teachers. Educators, students, and policymakers can all benefit from a better understanding of teachers' and administrators' experiences with chemistry classroom challenges if we can learn more about their perspectives on the topic. Contributing to the ongoing conversation on scientific education reform and fostering continual progress in the teaching and learning of chemistry ideas, this research aims to shed light on the issues faced by chemistry educators and explain the reasons determining their perceptions.

LITERATURE REVIEW

Teaching chemistry concepts can be challenging due to the abstract nature of the subject matter and the divers range of learner’s abilities and backgrounds. Understanding the factors that influence them is crucial for effective teaching strategies and curriculum development.

The subject matter's abstract character and the wide variety of students' talents and experiences make it difficult to impart concrete chemistry ideas to the general public. Effective pedagogical practices and course design depend on a thorough understanding of these concepts and the circumstances that shape them.

- Chemistry's Fundamental Concepts. Mathematical computations involving concepts and abstract theories are common in chemistry, making it difficult for students and instructors alike. In 2000, John Stone wrote, Students can make mistakes when trying to understand chemistry concepts because of how abstract they are, such as atomic structure or chemical bonding (Taber, 2013).
- The pedagogical content knowledge (PCK) of educators’: Teachers' grasp of the subject and their ability to make it accessible to students heavily influence the perceived difficulty of teaching chemistry. Knowing the subject matter

thoroughly isn't enough to be a competent chemistry teacher; one must also have pedagogical content knowledge, which is knowing how to effectively teach particular chemical ideas, Shulman (1986).

- Student, Factors: Teachers' assessments of their own chemistry classroom challenges are highly dependent on factors such as students' background knowledge, cognitive capacity, and intrinsic motivation (Taber 2002). Ensuring that all teachers understand basic chemistry topics while also addressing the needs and misconceptions of various pupils can be a challenge for teachers. Researchers Prieto and Canas (2018) noted.
- Lessons and Materials: The availability of appropriate curriculum materials, laboratory resources, and technological tools also impacts how difficult teachers perceive teaching chemistry to be, Aaman and Hofstan (2007). Outdated textbooks and limited access to equipment may hinder effective education and student participation in chemistry classes.
- Assistance with Career Advancement and Mentoring Teachers' access to support networks and opportunities for professional development influence their confidence and efficacy in teaching chemistry ideas. In 2013, Banilower and colleagues reported that mentoring programmes that provide ongoing training in inquiry-based teaching methods might help teachers gain confidence and improve their pedagogical skills when it comes to tackling difficult chemistry topics.
- The Socio-Cultural Context: Society's attitudes towards science and technology, as well as other socio-cultural factors, might impact how teachers see the importance and challenge of teaching chemistry ideas, Osborne and Dewitt (2011). In order to ensure that all students have engaging chemistry learning experiences, it is crucial to combat cultural stereotypes and advocate for inclusive teaching techniques. If we want to make science classes better, we need to look at how teachers feel about the challenges they face while trying to teach chemistry. We can all work together to improve chemistry education if we take the time to learn about the difficulties instructors have and then find ways to help them succeed in the classroom.

STATEMENT OF THE PROBLEM

Despite the significance of chemistry education, many teachers struggle to convey chemistry ideas clearly and concisely in the classroom. Understanding teacher's perceptions of these difficulties and the factors influencing chemistry instruction is very important. The research aims to investigate teacher's perceptions and determinants of difficulty in teaching chemistry concepts in the areas of qualifications, experience and gender, with the goal of identifying strategies to enhance chemistry education.

RESEARCH QUESTIONS

- What is the most challenging chemistry concepts according to chemistry teachers?
- Are teacher's academic qualification a factor of the perceived difficulty of chemistry concepts?
- Are the teacher gender a factor of their perceived difficulty of chemistry concepts?
- What are the reasons responsible for teachers perceived difficulty?
- Are the teachers teaching experience, a factor of their perceived difficulty of chemistry concept?

RESEARCH HYPOTHESIS

H01: There is no significant difference in chemistry concept perceived difficulty by qualified and unqualified chemistry teachers'.

H02: There is no significant difference in chemistry concept perceived difficult by experienced and less experienced chemistry teachers.

H03: There is no significant difference in chemistry concepts perceived difficult by male and female chemistry teachers.

RESEARCH METHODOLOGY

The study is a descriptive survey research. It attempts to analyze chemistry concepts perceived difficult by teachers and to investigate the factors of teacher's qualification, teaching experiences and gender on their perceived difficult concepts.

Population of the study

The population for study comprises all chemistry teachers in senior secondary school in Ondo State.

Sample and sampling techniques

A purposive sampling techniques based on qualifications, level of experience and gender was used. 112 chemistry teachers were selected from all the schools in Ondo State.

Research design

To gather data, a research-designed questionnaire was used, and all of the chemistry teachers from specific schools were asked to fill it out. Parts A, B, and C comprised the survey. In Section A, we asked for demographic information, including school name, gender of teachers, degree of education, and number of years in the classroom. In Section B, we used 30 chemistry concepts from the West African Examinations Council (WAEC) to test the students. On a Likert scale, (V.D) is the most challenging to teach, (D) is the least difficult, (E) is the easiest, and (V.E) is the most-easy. It was expected that respondents would explain why they found certain chemistry concepts challenging in Section C.

Validity of the instrument

To ensure validity of the instrument, the test item was screened by validators comprising of three science education professors and a senior secondary school chemistry teacher. Recommendations of the validators were used to revise the test item before a pilot test was carried out, using sampling of 40 chemistry teachers. The group of the teachers were not used in the main study. Responses were graded and analyzed on the basis of their perception of difficulty. To determine the reliability of the coefficient, it was re-administered to the same set of teachers four weeks later. The calculated test re-test reliability coefficient of the chemistry teachers sampling was found to be 0.76 using Pearson product moment correlation coefficient. The researcher personally administered instruments with the assistant of the head of department of science and the chemistry teachers in each school.

DATA ANALYSIS AND FINDINGS

The data collected were analyzed by using descriptive and inferential statistics, in addition t-test statistic was used to test the null-hypothesis formulated.

Table 1

Concepts	Frequency	Difficulty %	Frequency	% Easy
Redox reaction	90	80.4	22	19.6
Energy changes	82	73.2	30	26.8
Electrolysis	95	84.8	17	15.2
Mole	90	80.4	22	19.6
Organic compound	90	80.4	22	19.6
Oxidation & Reduction	88	69.6	24	21.4
Solubility of substance	92	82.1	20	17.9
Chemical Kinetics	86	76.8	26	23.2
Rate of chemical reduction	84	75.0	28	25.0
Metals & their compounds	80	71.4	32	28.6
Acid, base and salts	26	23.2	86	76.7
Atomic structure	32	28.6	80	71.4
Air	27	24.1	85	75.9
Periodic chemistry	24	21.4	88	78.6
Separation techniques	42	37.5	70	62.5
Water	27	24.1	85	75.0
Chemical bonds	26	23.2	86	76.7
Kinetic theory of metals	22	19.6	90	80.4
Chemical combination	17	15.2	95	84.8
Chemistry and industry	32	28.6	80	71.4
Chemical equations	22	19.6	90	80.4
Pollution	17	15.2	95	84.8
Nature of metal	37	33.0	75	67.0
State of matter	32	28.6	80	71.4

In Table 1, out of 112 teachers 90 (80.4%) of chemistry teachers perceived redox reactions concepts difficult to teach while 22 (19.6%) teachers perceived it easy to teach. The concept of chemical combination and pollution were ranked least difficult to teach indicated by only 17 teachers (15.2%) each.

Hypothesis testing

H01: There is no significant difference in chemistry concept perceived difficult by qualified and unqualified chemistry teachers

Table 2 Concept's difficulty and teacher's qualification

Qualification category	Number	DF	Mean	Variance	SD	Tval		Decision
						t-cal	t.tab	
Qualified teachers	60	110	52.74	41.7	6.2			H01
Unqualified teachers	56	110	58.44	48.4	6.5	3.12	2.000	Rejected

The results in Table 2 above indicate that there was significant difference in the perception of qualified and unqualified biology teachers tcal>t tab, that 3.12> 2.000 using mean and t-test at df 110 at 0.05 significant level. Therefore, H01 is rejected.

H02: There is no significant difference in chemistry concept perceived difficult by experienced and less-experienced chemistry teachers.

Table 3 Concepts difficulty and teacher's experience

Experience	Number	DF	Mean	Variance	SD	t-val		Decision
						t.cal	t.tab	
Experience teachers	66	110	60.44	42.84	6.53	4.66	2.000	H02
Less- experience teachers	46	110	52.43	39.36	6.28			Rejected

The results from Table 3 above indicates that t.cal>t.tab, i.e 4.66>2.000 using mean and t-test with df 110 at 0.05 significant level, hence a significant difference does exist as a result of which H02 is rejected.
H03: There is no significant difference in concepts perceived difficulty by male and female teachers.

Table 4 Teachers, gender and concept difficulty

Sender	Number	Df	Mean	Variance	SD	Tval		Decision
						t.cal	t.tab	
Male teachers	72	110	49.83	32.47	5.70	0.83	2.000	H03
Female teachers	40	110	55.44	51.22	5.82			Accepted

The results from Table 4 indicate that tcal< t.tab that is 0.83<2.000 using mean and t-test at df 110 at 0.05 significant level. H03 is therefore accepted.

Table 5 Teachers' reasons ranked in descending order/percentages.

Rank	Teacher's reason	Number	%
1.	Complexity/ Abstract nature of concept	90	80.36
1.	Poor knowledge of subject matter/wrong deployment of teachers	85	75.89
2.	Mathematical aspects	80	71.43
3.	Lack of real world relevance	60	53.57
4.	Low commitment	55	49.11
5.	Complex terminology	50	44.64
6.	Insufficient time allocation	40	35.71
7.	Unavailable instructional materials/insufficient time allocation	36	32.14
8.	Cumulative nature	30	26.79
9.	Teaching methods	30	26.79
10.	Miss-conception of concept	25	22.32
11.	Experimental nature	20	17.86
12.	No response	2	1.79

Table 5 shows the various reasons advanced by teachers. The highest ranked reason was complexity abstract nature of concept indicated by 55 (76.92%) teachers, while the least ranked reasons was experimental nature indicated by 9(17.31%) teachers. Other are: misconception of concept, poor knowledge of subject matter/wrong deployment of teachers and in availability of instructional materials/insufficient time allocation, etc.

DISCUSSION OF FINDINGS

The findings of this study revealed that teachers perceived 10 chemistry concepts out of 24 chemistry concepts presented to them as difficult to teach. These concepts are Redox reactions, Energy changes, Electrolysis, Mole, Organic compounds, Oxidation and Reduction, Solubility of substances, Chemical kinetics, Rates of chemical reaction, Metals and their compounds.

Research by Smith and Lingersoll (2004) found that experienced teachers have more positive perceptions of their teaching effectiveness and classroom management skills compare to novice teachers. Experienced teachers often develop a deeper understanding of pedagogy and students needs over time leads to more confident perceptions of their abilities. Similarly, Johnson and Burkeland (2023) found out that inexperienced educators may feel less effective due to difficulties in managing their classrooms and developing lessons. The demands of teaching could make them feel overwhelmed, which can lead to a general lack of positivity.

The researcher found out that there is a significance difference in chemistry concepts perceived difficult by experienced and non-experienced chemistry teachers. This is similar to the findings of Taba (2002), that suggest that misconceptions about bonding can persis even among experienced chemistry teachers, similarly Kousathana et al. (2015) found that teachers may struggle to effectively teach concepts related to equilibrium such as Le- chatelier's principle and equilibrium constant expressions can be difficult to grasp due to their dynamic nature, also Kind et al (2008) highlights the difficulties teachers face in conveying concepts like Acids & Bases, PH calculation, acid-base titration accurately. Similarly studies by Talanquer (2011) and Borges et al. (2013) indicate that teachers may struggle to help students develop a deep understanding of thermodynamic principles. Hu et al. (2005) and Barker and Miller (2000) in the research said concepts such as Oxidation-reduction reactions, electrolysis and electrochemical cells can be difficult to teach and learn, thus examines the challenges faced by teachers in conveying electrochemistry concepts effectively.

The researcher found out about gender that there is no significant difference in concept perceived difficult by male and female teachers. Which was in contrast to Smith et al. (2018) that found out that male and female chemistry teachers may perceive difficult problems differently, the study highlighted the need to consider gender dynamics when addressing challenges in teaching chemistry. Similarly, Johnson & Lee (2017) identified gender biases in the perception of difficulty in chemistry problems among teachers. The research revealed disputes in how male and female teachers assess and approach complex chemistry content, indicating the presence of gender-related biases in educational settings.
The findings of the study is also contrast to the views of Darling Hammond (2000) that educators who have completed graduate programmes or received specialized training may have a more favourable impression of their own teaching skills and methods. Additionally, teachers who participate in ongoing professional development opportunities tend to have more favourable perceptions of the effectiveness and job satisfaction (Guskey & Yoon 2009). Continual learning and skill development contribute to a sense of professional efficacy and confidence among educators.

CONCLUSION

While various factors including experience, gender and qualification can influence teacher's perceptions, it is essential to recognize the complex interplay of these factors within the broader context of education. Experienced teachers often have more positive perceptions of their teacher's ability while novice teachers may face challenges that impact their confidence gender can also play a role in perception, with female teachers sometimes perceiving greater barrier to career advancement but it is not so in this study because there was no significant difference. Additionally, teacher's qualifications and participation in professional development opportunities contribute to their perceptions of efficacy and job satisfaction. Understanding these factors is essential for supporting teachers and improving educational factors. Most especially it will help teachers to develop effective instructional strategies that will help students overcome their fear in the subject.

RECOMMENDATION

From this research the following recommendations were made:

1) Government should invest in professional development to enhance teacher's skills, knowledge and confidence in classroom.
2) Government should implement policies and initiatives that promote gender equity in education. Encourage mentorship programs & leadership opportunities for all.
3) Every school should recognize and reward experience by providing opportunities for leadership roles, mentoring, create pathway for career advancement that recognizes and reward years of service and dedication to its profession.
4) The schools should cultivate supportive and collaborative school culture where teachers feel valued, respected and empowered to succeed.
5) Teachers should explore different types of instructional strategies and pick the best that should suit the students.

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